STUDY ON IRRIGATION AND DRAINAGE NETWORKS OPERATIONAL PROBLEMS AND SUGGESTING APPROPRIATE SOLUTIONS: (CASE STUDY: MOGHAN PLAIN)

ETUDE DES PROBLEMES D'EXPLOITATION DES RESEAUX D'IRRIGATION ET DU DRAINAGE ET MESURES APPROPRIEES POUR LES RESOUDRE (ETUDE DE CAS : PLAINE DE MOGHAN)

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ABSTRACT

The study area of Moghan plain is located at the north of Ardabil province and south of Khazar Sea. The Aras River divides the plain into two; one being the I.R. Iran and the other is Azerbaijan. All the development projects in this plain of about 3500 km^2 draw water from this river. Such projects have been executed over 900 km^2 area of the plain. At present, Moghan irrigation and drainage network (IDN) supplies water for an area of about 656 km^2, comprising Argo-industries of Moghan (24,198 ha), Pars (4,855 ha), private farmers (35,572 ha) and other governmental organs (1,102 ha).

In this study, the present conditions of irrigation and related structures of the IDN, as well as the manner of the project operation and maintenance were considered with a view to diagnosing the factors responsible for reduction of the proposed life of the project. The study leads to the conclusion that special attention should be paid to the autumn and spring cropping irrigations to minimize water losses and consequent damage to the crops and hence, to the farmers of the plain with special reference to the following:

- *Preparation of an emergency but applicable solution agenda, to prevent physical damages to the IDN,*

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- *fundamental revision in the rules and regulations of operation and maintenance companies to cover the associations of the farmers and other water users, and,*
- *Preparation of the critical period program to face droughts, if any.*

Key words: *Irrigation and drainage network, Operational problem, Water requirement estimation, Moghan plain, Iran.*

RESUME

La région d'étude de la plaine de Moghan est située au nord de la province d'Ardabil et au sud de la mer Khazar. Le fleuve Aras divise la plaine en deux parties ; IR de l'Iran et Azerbaïdjan. Tous les projets du développement de cette plaine (superficie d'environ 3500 km2) tirent de l'eau de cette rivière. Ces projets ont été mis en palce sur une superficie de 900 km2. A présent, le Réseau d'irrigation et de drainage de Moghan (IDN) fournit l'eau à une superficie de 656 km2, y compris les industries agricoles de Moghan (24.198 ha), Pars (4855 ha), les fermiers privés (35 572 ha) et d'autres organes gouvernementaux (1102 ha).

Dans cette étude, les conditions actuelles de l'irrigation et des structures connexes de l'IDN, ainsi que les modalités d'exploitation et de maintenance du projet ont été examinés pour décider les facteurs responsables pour la réduction de la durée de vie proposée du projet. L'étude indique qu'une attention particulière doit être accordée à l'irrigation des cultures en automne et au printemps pour minimiser les pertes d'eau et les dégâts causés aux cultures et, par conséquent, aux fermiers de cette région. L'Etude fait une référence particulière à ce qui suit:

- *Préparation d'une solution d'urgence applicable pour prévenir les dommages physiques à l'IDN,*
- *Révision fondamentale des règles et des règlements des sociétés d'exploitation et de maintenance pour recueillir les associations des fermiers et autres usagers d'eau, et,*
- *Préparation du programme de période critique pour faire face à la sécheresse.*

Mots clés: *Réseau d'irrigation et de drainage, problème d'exploitation, évalutation des besoins en eau, plaine de Moghan, Iran.*

1. INTRODUCTION

Water has a vital role in economical and social life of Iran and achieving self-sufficiency in agricultural productions. The average annual precipitation in Iran is estimated as 413 billion cubic meters (bcm) of which, the usable component is about 130 bcm annually. From this, 88.5 bcm is being extracted and used in different parts. Water allocated to agricultural sector is about 82 bcm (Agriculture Department). The problems in water resources utilization in the country are insufficient duration and erratic spatial distribution of rainfall, large distance between the source and location of water consumption, high rate evapotranspiration, salty and sweet water intermixing and consequent salinization of fresh water and agricultural lands and little attention to the problems caused by natural conditions and geographical location of our country. For achieving better water utilization in agriculture, the following are important:

1. Control and justifiable allocation of water resources.
2. Control and distribution of water resources.
3. Revised and updated operation instructions.
4. Evaluation and comparison of anticipated operation program with annual performance.
5. Modification of existing operation charts in a way that participation of beneficiaries is ensured.
6. Regular monitoring of the system performance.

2. LITERATURE REVIEW

During 1993 to 1998, about 1.2 million hectares of irrigation network were assigned to water consumer associations in Mexico. Different reasons can be mentioned for transferring the management of irrigation networks to the water consumer associations, such as destruction of irrigation infrastructures due to lack of proper maintenance, reduction of allocated capital to the repair and maintenance and consequent farmers' alienation from the government controlled system. The government's inability to maintain the systems due to financial crisis caused the most rapid formation of water users' associations. In this system, each association formed expert groups consisting of one manager and several head water distributor and a maintenance supervisor. Gradually the educational centers, professional institute, etc., was formed (Goriz etal, 1995).

Jabari (2006) mentioned that operation and management of IDN should be based on the principles that as far as possible their primary goals were to be striving for improving the performance efficiency of the system to enhance production potential and consequently improving the welfare of the local community.

In this paper, while reviewing the fundamental principles of IDN design, application of these principles in the planning, operation and monitoring and evaluation of irrigation networks are discussed. Also, the fundamental principles of IDN design according to their primary goals and on the pricing of irrigation services are explained.

3. MATERIALS AND METHODS

Geographic location

Moghan is a wide plain in the north of Ardabil and west of the Caspian Sea, it is located on 47.5-48 degrees east longitude and 39.42-39.20 degrees north latitude. The Aras river divides this plain plain into two parts: Iran's Moghan and Republic of Azerbaijan's Mil.

Moghan network design goals

Moghan's IDN has been in operation with the aim of covering 72 thousand hectares by drawing water from the Moghan and Mil diversion dam. Mil and Moghan diversion dam are considered for water sharing between Azerbaijan and Iran through the sector valves which are installed on the crest. Currently Moghan's IDN is providing water to about 65,727 ha net area, which

includes 24,198 ha of Moghan's agro-industry lands, 4855 ha of Pars agro-industry lands, 35572 ha of private farm lands and 1102 ha owned by the state organs. Also 4000 ha of irrigable lands with pumping stations have been added to it.

The estimates primary sources water

Aras River, originating from the north foothills of Min Gol Dagh in Turkey travels 1073 km in mountainous and plains areas is the water divide between Iran and the Republics of Turkey, the autonomous Nakhichevan, Azerbaijan and Armenia. After joining with Kura River it drains into the Caspian Sea. The annual water consumption in the Moghan basin is about 3.147 bcm and about 2.55 bcm of it is provided by surface waters. Aras River's water quality according to Wilcox classification is of C2S1 class, which has no limitation in terms of agricultural water use.

Research Methodology

In this study, the procedures for investigation are as follows:

- ✓ Controlling and allocating of water resources (operation planning) comprising the following steps:

  First step: To meet the existing and future anticipated water resources demands, the annual amount of network's available water is estimated.

  Second Step: Based on the planned cultivation program and the overall network efficiency, water needed for irrigation are estimated.

  Third step: by comparing the results of the above steps, review and allocation of water resources can be done.
- ✓ Water resources controlling and distributing (program implementation).

  Water distributing method will be checked and if found unsuitable, alternatives are recommended.
- ✓ Program and operational methods for diversion dams and irrigation and drainage networks.

Operation problems, operation methods of the IDN and diversion and transmission systems are studied:

- Checking the plans to water dropping and water stopping in channels.
- Checking the irrigation planning method for the coordination between existing water resources and consuming requirements of network.
- Checking the allowed variation range for water discharging in channel.
- Checking the changes in water levels at the key points of the network
- Checking the effective factors in the water distribution management and delivery.
- Checking the controlling method and water measurement in the networks.
- Checking the operation instructions in the normal cases.
- Checking the operation instructions in the urgent cases.

- Checking the delivery priority in the normal situation.
- Checking the delivery priority in the urgent situation.

4. RESULTS AND DISCUSSION

Cultivation pattern in the current situation:

Cultivated area in entire irrigable lands of Moghan's IDN for first and second cultivations during the years of 2000-2001 to 2006-2007 have increased from 70,000 to 91,700 hectares (Table 1)

Table 1. Cultivated areas of whole irrigable lands (ha) of Moghan's IDN during 2000-2001 to 2006-2007

2006-2007	2005-2006	2004-2005	2003-2004	2002-2003	2001-2002	2000-2001	Product Type
35605.4	33487.3	29427.4	27825.6	26193.1	27957.5	20032.1	Wheat
847.0	1718.1	1509.8	9/1604	1519.4	2279.3	4581.1	Barley
5/4029	3266.0	3155.0	3277.4	3648.9	3664.0	3613.4	Alfalfa
3317.3	4289.7	9124.3	11756.4	11561.6	11914.0	18143.8	Cotton
2635.5	3617.4	2396.9	2112.2	2645.0	2999.9	3414.0	Sugar beet
1499.7	1547.8	2156.6	1345.1	1838.0	1038.7	1430.9	Corn
335.3	420.3	1074.6	784.0	986.4	1224.4	713.4	Forage corn
3636.9	3252.9	4135.4	4125.9	3991.6	3131.0	3242.0	Seed corn
55.4	8.0	7.3	7.5	8.5	11.8	32.6	Clover
260.8	97.7	166.0	230.3	624.4	212.4	450.3	Soya
7292.5	4742.1	2801.4	1529.0	1391.0	461.0	24.5	Canola
476.6	244.3	687.5	243.4	203.5	344.8	330.5	Kitchen garden
804.0	2/1066	7/978	3/449	3/894	3/1030	8/441	Tomato
1295.0	1069.0	2124.1	2515.9	2169.1	2394.8	2438.1	Gardens
784.0	710.0	730.0	618.2	628.2	580.2	520.0	Olive
490.8	1785.3	741.6	585.5	855.7	1136.6	2032.7	Other cultivated
2/64487	61332.0	61216.5	59011.0	59160.7	60380.5	61440.9	Total autumn and spring cultivation
22957.3	18400.2	15778.0	11995.8	10420.8	8838.7	6436.9	Total of second cultivation
91736.5	84716.7	80779.3	76531.9	73420.4	72817.9	70676.1	total

Estimation of water requirement for plants

The Penman Monteith method with the Perot adjusting was used for Estimation of water requirement for plants. The net required amount of irrigation water for common plants in the region is shown in Table 2.

Table 2. Net Irrigation need for agricultural crops in Moghan's IDN by Penman Monteith method (m^3/ha)

Product	Irrigation's net requirement (yearly sum)	Product	Irrigation's net requirement (yearly sum)
Wheat	2970.2	Cucumber	4078.91
Barley	2250.43	Clover	3159.26
Canola	2250.43	Sunflower	5354.59
Fine barley silage	1404.46	Lentil	6108.24
Sugar beet	6964.3	Bean	4825.85
Seed corn	5699.35	Olive	6310.25
Spring forage corn	5205.54	Tree	6442.21
Seed Sorghum	5363.68	Summer soya	4948.79
Forage Sorghum	6394.96	Summer seed corn	4198.30
Alfalfa	8084.51	Summer forage corn	3227.18
Soya	6279.44	Summer Grain Sorghum	3908.20
Cotton	6654.49	Summer forage sorghum	4252.30
Tomato	6266.64	Summer Barley silage	3584.50
Watermelon	5467.78	summer Sesame	4271.50

Annual volume of available water in Moghan plain (MCM)

Table 3. Volume of input water to the Moghan network since 2000-2001 to 2006-2007 (Mm^3)

Farming year								
86-85	85-84	84-83	83-82	82-81	81-80	80-79	79-78	Month
38.9	14.77	11.5	4/10	33.9	15.6	8.1	13.6	November
32.8	50.71	6.0	7/5	41.1	15.2	12.5	31.0	December
22.8	16.82	34.8	0/32	8.3	14.9	32.5	19.2	January
39.6	3.54	18.8	3/38	22.3	34.5	13.8	8.3	February
45.3	28/36	41.8	8/13	5.3	60.2	35.1	12.2	March
86.9	113.48	50.8	6/66	15.2	61.0	68.1	66.0	April
132.7	82.54	146.3	4/105	101.0	51.5	124.8	131.2	May
141.4	150.24	115.9	9/117	100.8	103.6	117.2	100.7	June
134.7	132.4	123.4	3/109	108.5	125.8	119.2	100.9	July
165.3	154.01	139.6	3/137	128.7	133.9	128.3	118.3	August
6/140	110.98	108.9	7/109	100.5	91.6	79.2	78.3	September
46.2	32.28	4/32	33.3	21.1	29.4	18.9	15.5	October
1027.1	898.07	1/830		686.6	737.3	758.0	695.1	Annual total

Estimation of yearly available water

Estimation of yearly available amount of water requires performing actions that are as follows:

- Collecting and controlling all the required information before starting yearly operations.
- Controlling and using the estimation results of river's updated flow at all dewatering points in different periods of irrigation.
- Comparing and controlling the measurements at all major dewatering points with updated flow to determine the amount of water consumed.
- Using floods and river's additional flows as part of the available water resources.
- Using information on estimated yearly rainfall amount, monthly distribution and effective amount of rainfall with the specified possibilities for using in compilation of the irrigation calendar
- Collecting statistics of daily rainfall and estimating effective rainfall amount for comparing with the estimates and determining its effects on available water resources.
- Predicting the amount of drainage waters backed to rivers for its use as surface and groundwater resources and estimating amount of exploitable water in each dewatering points of project according to its quality and distribution pattern in different months of the year.
- Studying the limitations and opportunities in order to coordinating in consolidated operation management of surface and groundwater resources and optimize utilization.

- Calculating total amount of consumed water from surface, groundwater and precipitation resources at the end of each farming year and its comparison with estimated values.
- Studying and predicting of available water for future farming years from the surface, groundwater and precipitation resources and finally predicting water distribution manner during the irrigation periods with specific possibilities.

Moghan Network's water balance

An amount of 1183.53 Mm^3 water has entered the Moghan network in the 2008-2009 farming year. This was consumed in agriculture, drinking, industry, hygiene and Moghan hydroelectric power plant.

Ignoring the water discharged from 3 bridges due to operation of Moghan hydroelectric power plant during the days that Parsabad irrigation region did not need to water (193.94 Mm^3), and the water available due to rains (36.6 Mm^3 for the IDN area), the input into the network is 953 Mm^3 in this farming year that shows increases of about 128 Mm^3 in comparison with last farming year.

Situation analysis of output water of drains:

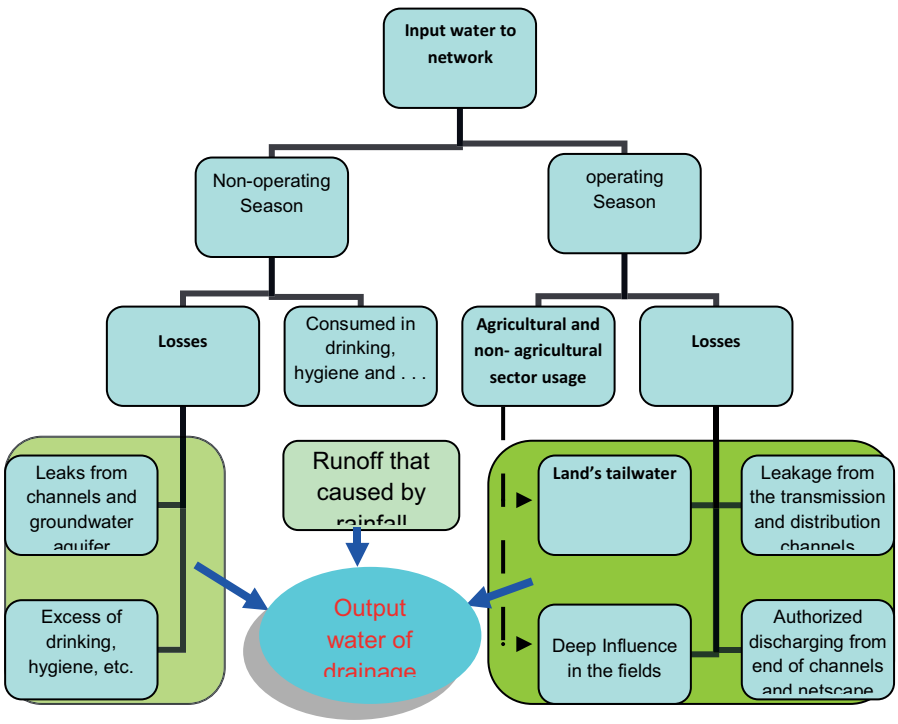

Fig. 1. Overview of network water balance

Table 4. Information about drains in 86- 87 farming year

Output water from drains after the base deduction		Base water of drains		Total output water from drains		Month
Volume (Mm^3)	Flow (m^3/s)	Volume (Mm^3)	Flow (m^3/s)	Volume (Mm^3)	Flow (m^3/s)	
7.6	2.92	11	4.24	18.6	7.16	November
9.7	3.73	11	4.24	20.7	7.97	December
9.3	3.57	11	4.24	20.3	7.81	January
7.6	2.94	11	4.24	18.6	7.18	February
5.27	1.89	10.63	4.24	15.9	6.13	March
12.54	4.67	11.36	4.24	23.9	8.91	April
18.64	6.96	11.36	4.24	30	11.2	May
19.54	7.29	11.36	4.24	30.9	11.53	June
20.14	7.53	11.36	4.24	31.5	11.77	July
19.94	7.44	11.36	4.24	31.3	11.68	August
19.14	7.16	11.36	4.24	30.5	11.4	September
14.9	5.76	11	4.24	25.9	10	October
164.39	-	133.81	-	298.2	-	Annual total

The total efficiency in *the agricultural sector (total efficiency of irrigation)*

The total irrigation efficiency (ET) is defined as follows:

$$E_T = \frac{Vm}{Va}$$

Where, (Va) is volume of input water to the network and Vm = volume of required irrigation water for evapotranspiration by the plant to avoid undesirable water stress in plant during its growing period (m) for agricultural use. According to above mentioned relationship, irrigation efficiency in the network was calculated as 40%.

Comparing annual water available with irrigation requirements

To determine the area under cultivation that can be irrigated by available water, the following should be considered:

- History of cultivation and area of each product in the region.
- According to demands of beneficiaries for cultivation in the next year, each product's area should be separately determined.
- Considering requests of beneficiaries and comparing it with the average of previous

years to plan for achieving to a required balanced and appropriate pattern for matching between production factors.

- Comparing the required water of beneficiaries with estimated amount of catchment area by considering other existing water resources within the network.

Table 5. Annual gross irrigation requirement of Moghan plain (at 40% efficiency)

2006-2007	2005-2006	2004-2005	2003-2004	Farming years
91736.5	84716.7	80779.3	76531.9	Total under cultivation area (ha)
672.76	585.985	541.27	513.9	Annual net requirement (MCM)
1076.4	937.57	866.032	822.24	Annual gross requirement (MCM)

Table 6. Comparing volume of supply and demand water in recent years

Difference percentage	Difference (MCM)	Volume of demanded water (MCM) (irrigation requirements)	Volume of supplied water (MCM) (annual available water)	year
95%	*-42.56	822.24	779.7	2003-2004
95%	*-35.93	866.032	830.1	2004-2005
96%	*-39.5	937.57	898.07	2005-2006
96%	*-49.3	1076.4	1027.1	2006-2007

*It shows lack of water

Studying the method and irrigation planning for coordinating between existing water resources and consumtion requirements of the network

- Studying the effective factors in distribution management and water delivery

  Effective factors on the water distribution and delivery are: water right, cultivated area, cultivation type, the location of the related basins, number of farmers, rate of cooperation and participation of farmers in keeping the related channels, paying the water price, lands must be prepared to start cultivation at the time of water flowing in the network and most important one is amount of existing water in the network.

- Studying the method or methods of water distribution and delivery

  This is for achieving compatibility between the water demand and water delivery. This is an imperative exercise in view of the fact that the network has high levels of technical standards in the terms of design and implementation and also in view of the fact that Iran's share of the Aras River water is only 15%.

studying the bottlenecks of volumetric water delivery

A - Criteria of water delivery and receiving the water price:

Water delivery should be volumetric and water price should be calculated and received in accordance to the volume of water delivered. In the Moghan network delivering the water to the consumer and receiving the water price is done according to area of under cultivation. Though there is some restriction in this network in volumetric water delivery per hectare, but the farmers do not pay their consumed water's prices for each cubic meter. Hence, they do not care much about reducing water consumption.

B - Determination of required deliverable water to the consumers:

Operation procedures in the Moghan network is based on water allocation and distribution planning at the beginning of each year. The net water requirement for agriculture is estimated according to the national document of water for the anticipated cultivation pattern, irrigation interval of 10 days, appropriate network efficiency and keeping provision for other water needs such as drinking, hygiene and industry. An agreement (protocol) is signed by the representatives of both sides for determining the share of water from Aras reservoir dam and Mill and Moghan diversion dam.

With starting of each farming year, irrigation areas are responsible for running the water distribution program as agreed and necessary monitoring is done by the office of operation studies. Together with delivering water to lands, controlling the output of lands and finally controlling output water amount of area's drainage is another duty of distributing agents. Also water delivered to each farmer is recorded in the office of water distribution agents every day and distributed water in each channel and output of each drainage is reported and area and will be announced to headquarters by region.

- Studying the operation instructions in ordinary situations:

In activities of operation and maintaining company of Moghan Plain's irrigation and drainage networks in the field of operation we can mention the followings:

Operation Company from Moghan's IDN is responsible for all issues that are related to operation and maintenance of network. In this regard, its main duties are as follows:

- Managing and operating from Moghan and Mil diversion dam reservoirs, irrigation and drainage channels, pumping stations and other water facilities of network for allocating, transferring and distributing water to irrigable lands and other consumers according to the contract signed with members of network.
- Maintaining network, including adopting measures and performing the operation that facilitates the operation from the network and prevents damages to it.
- Performing required repairs of network, manufacturing and installing of valves, etc., within the company's capabilities
- Providing public services for ground and buildings of Pars Abad residential camps, lake and Byleh Savar, official buildings of headquarters and districts, pumping stations, dam and basins, etc.

- Safe upkeep of machinery, official buildings and camps of organizational houses, and facilities and buildings of dam and basin.
- Water contracting with water users who are protected by Moghan irrigation and drainage network, for selling the water.

➢ Studying the operation instructions in emergency situations:

A – Forming the promotional meetings with farmers about the optimum use of water resources and reducing cultivated areas of secondary products:

For possible water shortage crisis occurring in the network, it requires that farmers will be appropriately informed about status of water resources and motivated them to optimally use the existing water. Experts of region are emphasizing on irrigation at night, full time presence of irrigator in the field during the irrigation, avoiding excess use of irrigation water.

B – Using the water of drains and tailwater of upstream lands:

All farmers will be allowed to take the water and irrigate their own lands using pump and following the announced technical rules.

Water delivering priorities in normal and emergency situation

Delivering priority in normal situation is based on the relative demand with few day gaps in water delivery to the farmer after demanding water.

In emergencies such as droughts, water delivery has its own program including rationing of water, prioritizing water distribution among farmers according to location of water delivering site, etc.

Studying creating history of farming associations in Moghan IDN

Forming Limitations of water consuming groups:

A: **Social limitations**

- Farmers' belief that water is a free commodity.
- Cynicism caused by corporate farming organizations, including farmers fear that their land properties fall in to risk so that instead of creating farming association, they are willing to pay any penalty.
- Negative perceptions of farmers about the corporate farming organizations.

B - **Economic limitations**

Although lack of attention by regional authorities to the importance and economic aspect of water was one of the major problems in the past, fortunately, with the boom in country's farming endeavour, the problems are gradually reducing. Moreover, since the required investments in the network has been made previously, executer organizations of irrigation associations

are not facing much limitations in this issue. However lack of knowledge of farmers and their indifference to economic aspect of organizations compared with momentary and individual benefits is one of major limitations. Rather personal benefits such as job creation for their children, production increases, providing water for dry farming lands and providing irrigation security for agricultural sector were more important to the farmers.

C - **Financial Limitations**

- Financial problems of agricultural managers in buying transport vehicles and hiring the required personnel and other required facilities for managing and leading at least 500 required irrigation organizations is a major limitation.
- Worries of farmers for receiving water for surplus lands, despite not paying irrigation dues in the past.
- Difficulty of water charge collection due to distributed habitat of association members and the fact that the irrigation contract will be null and void if even one of the members does not pay the water price.

D - **Land ownership limitations**

- Worry that the land ownership may be at risk if corporate bodied start farming enterprise.
- Depriving independence in making decision
- Land division between the inheritors and having party irrigation card so that even one member of the inheritors does not agree with it forming group will be difficult.
- There are a considerable amount of surplus storage lands within the network in addition that they do not pay the current water price, they do not want to express and pay the water price of land.
- Worry about revealing surplus land and the fear that surplus land will be taken back.

Farmers with less land (< 3 ha) worry about having some problems in water delivery, as they are exempt from paying penalty.

5. CONCLUSIONS AND RECOMMENDATIONS

The last column of Table 6 shows that 95% of water requirement is supplied by the network and other 5% is through rainfall, drainage water, etc., and hence, there is no shortage in this network.
The most important problems in the exploitation in IDN of Moghan plain are as follows:

- Lack of appropriate planting patterns by related organizations.
- There is no compiled guideline of operation system in the network
- Due to lack of sufficient information about new methods of irrigation and agriculture, farmers adopt traditional methods of irrigation that is causing network's low efficiency.
- Agricultural development in outside of the network.
- Shortcomings in social and economic studies, ownership systems and land integration.

- lack of attention to on-time irrigation of autumn cultivations.
- Neglecting the proper operation of third-rate rivers and water leaking from small channels.
- Problems of dedicated drains.

Statute of Moghan Operation Companies

- Company shareholders are mostly government functionaries. Fifty one per cent of the share holders, who were supposed to be private institutions, are two cooperatives which consists of government employees.

  This subject has caused state vision be dominated to entire structure and performance of corporate
- The company's main objective is agricultural water distribution and optimize utilization of Moghan irrigation network. That is why the company is named as: Operation and Maintenance Company of Moghan Irrigation Networks. Its scope uniquely is this network. It is the company's wish whether to assign or not to assign any operation and maintenance work to the beneficiary farmers.
- The affairs of Ardebil and East Azarbaijan Regional Water Organization is in priority. Hence, the company cannot contract with other systems and its only income source is Water Organization contracts.
- Presidency of general meeting that determins board members and appoints the Manager, has been introduced in the context.

Offering Solutions and suggestions

For improving and removing water exploitation problems and making water available to the over 100 thousand hectares, the following plan is suggested:

1- Estimation of irrigation needs

This estimation is needed to forecast cultivation pattern and determining irrigation efficiencies and to bring harmony in operation of the respective activities of the irrigation company and the farmers.

- Cultivation program

In the plans that network management has required authority from the farmers for changing the cultivation pattern, simplest way for creating balance between water supply and demand is to let the farmers submit their cultivation pattern to network management for study and approval.

Required operations to determine cultivation program are as follows:

- Collecting and using data and meteorological information to calculate irrigation water requirement and determine precipitation conditions in drought and wet years.
- Take help from the existing soil science studies to assess land limitations in irrigation.

- Studying the results of washing out of soil minerals.
- Controlling quality of irrigation water that is used in agriculture and identifying limitations to estimate the required water for irrigation and leaching.
- Studying the changing necessity of region's cultivation pattern according to state agricultural policy, operation system of lands, climatic conditions, social - economic needs, etc.
- Studying the performing methods of good farming operations to improve irrigation operations.
- Studying and controlling cultivation pattern in improving physical properties of the soil.

2- Study and allocation of water resources

A- Revise cultivation program:

To strike a balance between water demand and supply, three main solutions seem to be effective:

- Changing cultivation date:
- Reducing cultivated area:

Reducing under cultivation area is simplest way to reduce the amount of demanded water that its application in practice is very difficult. Usually it indirectly is performed through the reduction of water quotas that it might finally lead to reduction of under cultivation area, Usually on equal terms, farmers prefer that in relation with cultivation pattern changing their water quotas reduce, because in this case they are reserving probability of cultivating more area by accepting precipitation probability or giving less water to cultivated products.

B- Changing water distribution program

This changing in can be done two ways:

A –B- Keeping conventional distribution methods by adjusting quotas.

- Determining more priority and quotas for valuable products.
- Reducing the amount of irrigation water in allowable limit.
- Prolonging the irrigation Period.

B-B- Studying the changing possibility of conventional irrigation methods to new methods:

- Irrigating by drip method.
- sprinkler irrigation.

C- Increasing irrigation efficiency through the:

- Covering of channels.
- Reducing operational losses.

- Study and allocation of water resources based on water needs of plants and cultivation patterns and other uses
- Training farmers about irrigation methods.
- Balancing in water use through the receiving appropriate water price.
- Applying correct management of irrigation.

3- Water distribution methods in Moghan network

According to water distribution conditions in the main and ancillary networks and by considering existing conditions of plan and region in the main network, steady flow with variable discharge will be adopted according to water requirement program of lands in different months of the year. The main advantages of this method are easy irrigation planning and matching possibility with high consumption and low consumption months in the project area. Water delivery in sub-networks are done according to predetermined program and water controlling and distributing is done by water mans.

4- Water price calculating and pricing in Moghan network

1 Water price calculating and pricing according to area of lands

2 Water price calculating and pricing according to water volume

5- Offering solutions for the official formation of water users associations:

- Formation of water consuming groups must be compulsory by establishing laws and regulations that they have executive and strong supports.
- Accelerate licensing for agricultural optimum water consuming
- Considering and giving facilities that are in article 11 of regulation of optimal use of agricultural water
- Contracting in three- stage as spring, autumn and summer irrigation
- Studying and planning for installing automatic or counter measurement systems to avoid future social problems and to prevent water wasting and to reducing number of waterman
- Announcing water price impunity of previous years when farmers are forming the farming organizations.
- Impunity of sharing-right from lands under the network that are irrigated from the network for years but area of lands had listed below in the card.
- Attention to technical personnel teaching for agriculture management and operational companies, and teaching irrigation leaders to raise their knowledge and skills.
- Preparation of administrative rules and regulations for this that how continue working and how groups work
- Creating support units for providing the training and guidance services, as well as evaluation and monitoring units in the agricultural management

6- Suggestions to tackle possible droughts in the future years

Considering that Khodaafryn and Aras reservoir dams with proper capacity for storing required water of the Moghan network are constructed on Aras river, the in time planning and water storing in the reservoir of dam in non-irrigation seasons could be effective in dealing with the network water crisis.

Forming the crisis committee and dealing with drought phenomena by updating drought problems and providing program for coping with drought in the form of county staff for supporting and cooperation of all of those involved and separating duties and responsibilities and explaining relationship between city executive agencies.

Improving storage of Aras and Khodaafryn reservoir dam by the in time performing of reducing output water from Aras dam during precipitation and when because of various reasons, network's used water is reducing and these cases are the most appropriate time to reduce discharged water from the dam.

Compiling plan and instructions for dealing with drought regarding to agriculture and irrigation issues such as appropriate cultivation pattern in drought time, proper irrigation ration and other effective parameters in the rate and quality of water use


MOGHAN IRRIGATION PROJECT
pilot farms
REPUBLIC OF AZARBAIJAN
ARAS RIVER
LEGEND
MAIN CANAL ALIGNMENT
SYPHON ON MAIN CANAL
AQUEDUCT FOR MAIN CANAL
CROSS - REGULATOR ON MAIN CANAL
BOX CULVERT ON MAIN CANAL
PIPE CULVERT ON MAIN CANAL
SUPER PASSAGE ON MAIN CANAL
CUT &OVER CONDUIT
INTAKE-TURNOUT
DISTRIBUTARY CANAL ALIGNMENT
DRAINAGE CHANNEL
EXISTING CANAL A
EXISTING BOX CULVERT
BOUNDARY OF PUMPING BLOCKS
EXISTING CENTERS OF POPULATION
CONTOUR (METERS)
ROAD BRIDGE
DAM
MAIN CANAL & CANAL A
SECONDARY CANALS
MAIN DRAINS (OUTFALL)
N

REFERENCES

Agriculture Department. Technical and infrastructure deputy, general department of development of irrigation sub-networks, project improvement report of Moghan plain's irrigation and drainage sub-networks.

Abolhassani, Jalal. General department of irrigation sub-networks development. 2005. Water wave in Irrigation channels and its effects on structures in the Moghan irrigation and drainage networks. Irrigation and drainage MS thesis. Islamic Azad University- Tehran science and research unit.

Gaderi, Abbas. Framework of performance evaluation of irrigation and drainage networks, water and development, the sixth year, new course, first number. Page 14-28.

Shabanie Qomi, Hossein. Dastgerdi Zarei, zahra. Mokhtari Hesari, Arezu. 2005. management transferring of irrigation networks to beneficiaries, the implications of optimize utilization of agricultural resources. The first regional conference about exploitation of water resources of Karun and Zayanderood basins (opportunities and challenges).

Lordan, Mehdi. Keramat, Morteza. Mansouri, Mahkameh. 2004. Studying the existing problems of Khuzestan irrigation and drainage networks. First national conference on irrigation and drainage network management.

Siahi, M.. H, Nasher. A., Farhadi. L, Jafari. M, Moalemi. L, Jabari. AS, Dalal Zadeh. AS, Salamat and Dasdar 2001. Management planning, operation and maintenance of irrigation and drainage networks. Publications of Iranian national committee on Irrigation and Drainage No. 60. Page 133.

Zolfaghari, Ali. 30 February 1997. Necessity of irrigation and drainage systems performance assessment, Articles collections of technical workshop for performance evaluating of irrigation and drainage systems. Page 33-19.

Genaat, Mohsen. 2009. Studying the problems operation and maintenance of Isfahan city irrigation network in the right side of waterfall for transferring exploitation and maintenance operations to agricultural organizations. Islamic Azad University- Tehran science and research unit.

Modarresi, A. 1999. People's participation in Dez irrigation networks. The first workshop about farmers participation in the management of irrigation networks. Site of Iranian national committee on irrigation and drainage. Page 39-31.

Kaveh, M. 2005. Assessing effective factors in participation rate of private sector in exploitation and maintenance of irrigation and drainage networks (case study Saveh dam irrigation system). Irrigation and drainage MS thesis. Islamic Azad University- Tehran science and research unit.

Jabbari, A. 2006. Design principles of most logical framework to achieve the goals of designing irrigation and drainage networks. Technical workshop on irrigation and drainage network management. Site of Iranian national committee on irrigation and drainage.

Koppen , B. , R. Parthasarathy and C. safiliou.2002.poverthy dimensions of Irrigation Management Transfer in Large – Scale Canal Irrigation in And Pradesh And Gujarat , India . Research report No. 61, International Irrigation Management Institute (IIMI), Colombo, Srilanka.

Guidelines for designing and evaluation surface Irrigation system, FAO Irrigation and Drainage papers – no 45. 1989.Rom.

Willardson, L. S. And B. H. Anderson . 1993. An experience in irrigation privatization and drainage (water management in the next century), the Hague, the Netherlands. ICID Transactions, vol. 1-F, Question 45, R 30 – R 49: 453-462.

Goriz, C. M., A. Subramanian and J. Simas.1995. Irrigation Management Transfer in Mexico: Process and progress, World Bank Technical Paper N0. 292.

Oorthuizen, J., and W.H. Kloezen. 1995. the other side of the Coin: A case study management performance in the Philippines. Irrigation and Drainage systems, : 15-37.

Vermillion, d. I. 1997. Management devolution and the sustainability of Irrigation : Results of Comprehensive Versus partial strategies, presented at the FAO and Rural development, Rom. Z word Bank Technical consultation on Decentralia